

THE Sidereal Messenger.

Conducted by Wm. W. PAYNE,

Director of Carleton College Observatory.

JUNE, 1882.

CONTENTS:

"The Voice that rolls the stars along
Speaks all the promises."

	PAGE.
Hints on Double-star Observing, (concluded)—S. W. Burnham.....	73
Aurora Borealis in Minnesota—Chas. S. Bryant.....	88
Observing and Recording Meteoric Phenomena—E. F. Sawyer.....	91

CORRESPONDENCE.—

Note on O ³ Eridani—A. Hall.....	94
Hints on Double-star Observing—O. Stone.....	95
Wells' Comet—G. W. Hough.....	96

EDITORIAL NOTES.—

William R. Brooks' Observations...Comet Wells'...Professor Stone's Appointment as Director of the Leander McCormick Observatory of Virginia...Moon Pictures...Warner Scientific Prizes...Death of Rear Admiral John D. Rodgers...Remarkable Vacuity...Auroral Displays...Mr. John Byrne's Telescopes...Mr. Hess' Observations of the Comet...Solar Eclipse...Vienna Refractor...The Lyrid Meteors...Flint Disc for Lick Observatory...C. H. R. and May MESSENGER...Mr. Draper's Photographs...Lalande Prize...Definitive Positions of the Red Stars...New Astronomical Journal...Spectrum of the the Nebula of Orion...Transit of Venus...Names of New Planets...Variable Stars.....	96-104
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The Sidereal Messenger.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 1.

JUNE, 1882.

No. 4.

HINTS ON DOUBLE-STAR OBSERVING.

BY S. W. BURNHAM.

MAGNITUDES.

In the matter of magnitudes, it is much the best to employ the Struvian scale. The fact of its use in all the observations of both the Struves, Dembowski, and other great double-star observers, is a sufficient reason for preferring it to any other. In this scale a star of any given magnitude is supposed to have four times the light of a star one magnitude fainter; but the recent photometric observations of double stars made at the Harvard College Observatory tend to show that practically Struve's magnitudes are about the same as those of a later scale where the light ratio is 2.5 instead of 4. It is sometimes convenient to know what is the faintest star which can be seen with any given aperture. In a general way it may be stated that if the diameter of a telescope be doubled, its seeing power will be increased one and a half magnitudes. The following table, based upon a light ratio of 2.5, is from Newcomb and Holden's *Astronomy*:

Aperture. Inches.	Minimum visible. Magnitude.	Aperture. Inches.	Minimum visible. Magnitude.
1.0	9.0	6.5	13.1
1.5	9.9	7.0	13.3
2.0	10.5	8.0	13.5
2.5	11.0	9.0	13.8
3.0	11.4	10.0	14.0
3.5	11.7	11.0	14.6
4.0	12.0	12.0	14.4
4.5	12.3	15.0	14.9
5.0	12.5	18.0	15.3
5.5	12.7	26.0	16.1
6.0	12.9	34.0	16.6

VARIABILITY.

In this connection a word of caution in respect to charging double-stars with variability should find a place. All experienced observers, and a great many of the other class, make too little allowance for the "seeing," and very frequently ascribe the difficulty of observing a particular star, or the failure to see it, to some mysterious variability in its light. I repeat here what I have more than once asserted before, that in the lower magnitudes there is not a single double-star known where there is any satisfactory evidence of the variability of the companion.

Of course, such instances may exist, but I know of no star where the observations, when carefully sifted and compared, even tend to establish it. I am aware of the adverse opinions of some eminent observers with reference to special objects; but I think much of the difficulty experienced in catching these faint stars, if not all, may be attributed to the seeing. For instance, an observer looks at the sixth star of the trapezium with, say, a six or eight inch aperture, and fails to see at all what, on a previous occasion, was very plain, and immediately comes to the conclusion that the star is variable. The fact is, that the very best proof in the world of variability would be furnished by always seeing unequal pairs of this class with any moderate aperture. If any one will examine with an aperture of seven or eight inches the double stars discovered with my six-inch, he will find a great many variable double-stars, if such a condition can be inferred from an entire failure to see many of them on ordinary, or even good nights, and this will be just as true if a still larger aperture is employed. A steady air and good definition are indispensable, and one cannot always tell just how good these conditions must be until a trial is made. There are comparatively few working nights when I do not place the instrument on some star, the companion to which I am unable to see; and never, in a single instance, has such failure led to even a suspicion of any change in the star. It is exactly what one would expect if the star was not variable. There is no kind of night which is the best possible for all kinds of observations, even

of double-stars. I have frequently had stars, which I thought might be double, on my list for examination for many months, and in some instances several years, before I could be absolutely certain they were really double. It is necessary to keep trying until just the right conditions are found, and then the doubtful star may come out plainly enough.

It has been said that a much larger aperture is necessary to discover a star than to see it when its place is known. It is easily seen how this might be true of persons not particularly accustomed to this kind of work; but it ought not to be true of practiced observers, and certainly is not in accordance with my experience. I have never been able to see any sort of advantage from knowing anything about a double-star in advance of the observation. A few seconds only are sufficient to examine as carefully as it can be done every quadrant, and to see all that can be seen on that occasion. I have, generally, seen a faint star of this kind better at the time of its discovery, than at any subsequent time; and, therefore, very early adopted the plan of carefully estimating or measuring the position of the new star when first found.

What has been said about uncertain observations does not apply so well to close pairs, as to very unequal ones. In the case of a pair much below the separating power of the telescope, an elongation may be suspected, which a better night or a larger instrument will show is not real. It is well to make a note of such stars, even under ordinary atmospheric conditions, as some of them are certain to prove to be really double. I have discovered a good many objects of this class under such circumstances; and, in some instances, where the pair was very close, have kept it on the list for perhaps a year, examining it on every suitable occasion when convenient to do so, before I could feel quite certain of the duplicity. A very close double-star does not look like a single star, even when it is impossible to guess at the direction of the elongation with any certainty. It would be difficult to describe or even point out any peculiarity in the appearance of the star. One is impressed with a difference long before a steady air and high power make an

elongation decidedly apparent. In this way I have frequently found stars on an indifferent night which proved to be exceedingly difficult under the very best circumstances. And so, observing with a very small instrument when the very best work can be done within the range of the aperture, stars will be found which do not look like single stars, but it will be impossible to say more with certainty, and they must be examined with a larger aperture. The double-stars, β 260 and β 291, are examples of what will sometimes be done in this way. The latter pair was for a long time suspected with the six-inch, and subsequently verified, and found to be a difficult object with a 26-inch aperture.

The highest power is not the best in searching for new pairs, even under the best atmospheric conditions, for although it will show extremely close pairs better than a lower power, it will wholly fail to show other classes of pairs. With a six-inch aperture, the best general working eye-piece will be a power of about 200. That will show most of the minute stars as well as any other power, and with it the practiced eye will rarely pass any pair down to $0.4''$ in distance, without suspecting something, and trying a higher power.

EYE-PIECES.

It will be a great saving of time to have the eye-pieces so arranged that when pushed into the adjusting tube they will be in exact focus. This is easily done in this way: push the highest power into the tube as far as it will go, and then focus it very carefully upon a close pair not far from the zenith; then remove this power, and put in the others successively, without disturbing the tube or touching the focusing screw, and after getting the exact focus, mark on the side of the eye-piece the precise place of the end of the tube. Then a collar of tin extending to this mark can be fitted in a few minutes which will serve as a stop when the eye-piece is placed in the tube. This collar may be narrow except at two points on opposite sides, which is well to have rather too wide than otherwise, and then work down with a file. Of course an excellent night will be selected for marking the eye-pieces, and all possible care exercised in

getting the best place for each power. With the eye-pieces fitted on in this way, when one is in focus, any other may be substituted without loss of time; and when it may be necessary to do this perhaps fifty times in a night, it is not an unimportant matter. I can speak with the utmost confidence of the practical value of such an arrangement. It is only on very fine nights that any improvement in the focus need be attempted, and then but rarely. When the micrometer is attached, this is already provided for, as each eye-piece when pushed or screwed into its place will be focussed on the wires.

WORKING LIST.

For micrometrical observations, two working lists should be prepared, one containing very close and difficult pairs, and the other, wide and comparatively easy pairs, each arranged in order of right ascension. A very convenient arrangement is to put each hour of right ascension on a separate, closely ruled page, and have the leaves cut at the edge like an index, putting the hour on the marginal part of each leaf, so that the book can be opened at once at the desired place. The lists should contain the name, right ascension, declination, angle, distance, and magnitudes of each pair, which should have a place on the page in proportion to its distance from the commencement of the hour. Additions can then be made to the list at any time, and the stars inserted in their proper places. By arranging and classifying the stars in this way, much time will be saved in finding suitable and convenient objects for observation. In making up the lists, the most interesting objects of each class within the range of the instrument will be selected, and particularly those which have been overlooked or neglected by observers heretofore.

More than 10,000 stars have been catalogued as double, but the number of pairs sufficiently interesting to merit any attention is smaller than is generally supposed. It is safe to say that altogether we shall find less than 3,500 stars within 120° of the North Pole, which, judging from the magnitudes and distances of the companions, are of any considerable importance; and a large number of these have their relations so far determined as to render observations for the present unnecessary.

RECORD OF OBSERVATIONS.

For an observing book I have used for a long time, a common blank book, to be found at any stationer's, about six by seven and a half inches. Any blank book will answer the purpose, but this will be found to be as suitable as any other. A small brass clip, such as is used to hold papers together, is very convenient for keeping the place, as the book can be opened to the right page without a light at once. All printed or blank forms of any kind for double-star measures are worse than useless, and of no conceivable advantage. The necessary entries are few and of the simplest possible character, and can easily be put in one-fourth of the space occupied by some of the printed forms which have been suggested, which generally contain places for many things no one should ever think of wasting time by filling up. Perhaps I cannot better illustrate my idea of the most convenient way of making the entries, than by copying the page of my own observations, which shows all that is necessary to put down. This is a portion of my measures made on the last working night, given in the order in which they were made. It is in every respect an exact copy of the original entries, and fairly represents all that is ordinarily written on any occasion.

April 25, 1880-315.

♋ Canceri. (8 ^h 5 ^m 20 ^s .)				Regulus. (10 ^h 2 ^m 0 ^s .)			
			5 . . . 5.2 V.			8.3 . . . 13 II.	
9 : 30	85.5°			B C 86.5°	49.662	.236	
	4.3		(85.6°		6.8	.710	(87.7°
	4.7	.905	.020		7.3	.705	.218
	6.2	.900	.014		8.3		
	6.0	.908	.014		8.0	.692	.224
	85.3	.904	.016		87.4		
♌ 3121. (9 ^h 10 ^m 46 ^s .)				39 Leonis. (10 ^h 10 ^m 39 ^s .)			
			7.0 . . . 7.5 (3rd quad.) V.			6.0 . . . 11.8 II.	
			Well separated.				
10 : 00	24.4°			117.0°			
	19.0		(199.8°		7.0		(298.4°
	19.4	.919	.002		9.2		(6.91°
	18.5	.905	.999		7.5	49.345	.572
	19.2	.908	.995		9.9	.382	.546
					8.3	.333	.582
	19.5	.911	.999		118.1	.353	50.563
							49.353
							1.210

The right ascension of the star is given in parenthesis following the name, then the estimated magnitudes, and the number of the eye-piece used. In these observations, eye-piece V is a power of 900. There is no occasion for inserting the declination. The right ascension is all that is needed for indexing or referring to any catalogue or list. The sidereal time of the observation is written on the left. The footings of the several columns, and the reduced angles and distances on the right were, of course, made subsequently. The parallel reading of the position-circle at this time is $89^{\circ}7'$; hence, the mean angles require a correction of $+0.3^{\circ}$. The figures in the second and third columns are the readings of the divided head of the micrometer screw, in thousandths of a revolution, on each side of the fixed wire. In pairs not exceeding two or three seconds distance, it is not necessary to read or record the number of the revolution, and only one side in any case, the coincidence of the wires, of course, being known. In this micrometer the coincidence is made at 50 on the scale, and, therefore, if the scale reads 49, as in the observation of 39 Leonis, the other side must be 50. The double distance is 1.210 revolution, half of which, multiplied by the value of one revolution ($11.42''$) gives the measured distance. To facilitate this work, and to avoid errors, a table should be prepared from which the values can be taken at once. The following is a portion of such a table, based upon the value of the screw used in these measures:

	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	
.00		0.1142	.02284	.03436	.04568	.05710	.06852	.7994	.08326	.10278	.00
.01	.1142	.12562	.13704	.14846	.15988	.17130	.18272	.19414	.20556	.21698	.01
.02	.2284	.23982	.25124	.26266	.27408	.28550	.29692	.30834	.31976	.33118	.02
.03	.3426	.35402	.36544	.37686	.38828	.39970	.41112	.42254	.43396	.44538	.03
.04	.4568	.46822	.47964	.49106	.50248	.51390	.52532	.53674	.54816	.55958	.04
	etc.		etc.		etc.		etc.		etc.		

This is equally useful in reading long distances, due regard being paid to the decimal point. For instance, if the double distance is 10.628 revolutions, we shall have from the table:

$$\begin{array}{r} 5.3 \\ .014 \\ \hline \text{Distance} = 60.6-6 \end{array}$$

The double-stars measured above are good representations

of moderately close and nearly equal pairs, and very unequal components. Three of these are interesting physical systems. The companion to Regulus was measured for the first time two or three years since. It requires a large aperture, as the companion has not more than one-third of the light of the companion to 39 Leonis ($\theta\Sigma$ 523). Many of the later measures of Σ 3121 require a correction of -180° in the position-angle.

The measures should be copied into a record book, the page being wide enough to rule the following columns: current number for indexing; name of star, or designation in Σ , $\theta\Sigma$, etc.; right ascension; position-angle; distance; date expressed decimally; sidereal time; power, or eye-piece; the remaining portion of the page being used when necessary to indicate the particular components measured, as B, C, etc., and for other notes. When the first measure of a star is written in, a sufficient number of lines should be left before entering another star, to put in subsequent measures. As a general rule, each star should be measured on at least three nights, and oftener in the case of very important and difficult pairs. The stars should be indexed as fast as they are copied in, for which a book similar to that used for the working-list may be used, or a large sheet of paper, folded so as to make at least 24 narrow pages, and then cut and stitched at the back. A sheet of this kind, making a page eight or nine inches in length, will afford room for indexing at least 1,500 measures without much crowding. Of course, only the name of the star, right ascension and reference number will appear here. The observer can tell instantly whether he has measured any particular star, and if so, can turn at once to the observations. New double-stars should be put in another part of the book, three or four on a page, leaving sufficient space to put in all subsequent measures.

It will be very rarely necessary to put down in the observing-book any more than is shown in the foregoing observations, and on an average the observer will not need to write half a dozen words a night. Unless the night is very fine no entry need be made of stars not seen, or not seen well enough to measure. This will occur very frequently if the

more difficult stars are looked for. It may happen once a week that it will be necessary to indicate the quadrant. This will be in measuring pairs where the components are so nearly equal that the angle may be reversed, but it will be important to attend to this only in very close and rapidly-moving couples, and particularly when they have been supposed to be recently single. This may be done by a diagram, but much the quickest way is to note, after the magnitudes, either the quadrant or estimated angle. In all other instances the observer will know by the description in his working-list whether he has set on the right object, and will notice an error in the direction, if any exists, and will be sure of the identity of the object before proceeding further.

AMOUNT OF WORK.

The amateur observer may wish to know how much micrometrical work he should ordinarily be able to do. This will depend upon the zeal and industry of the observer quite as much as upon the state of the weather. All large telescopes are, to a greater or less extent, more troublesome to manipulate than small ones. The moving of the dome necessarily requires more time, and fewer stars will be observed than with a telescope of moderate size. One may make fifty measures in a night, but half this number is a good night's work, and the average will be represented by a much smaller number. The amateur observer, who has other duties during the day, and cannot therefore, use the entire night for astronomical work, except on special occasions, should make in a year, with the average amount of clear weather, at least one thousand separate measures. If he has leisure, and is free from business cares, he will naturally do much more each night by making longer hours, and in a year should accomplish nearly twice as much. When a first-class night comes, the earnest observer will make the most of it, and will, of course, indefinitely postpone going to bed for a night or two at least. He will prefer to get along with three or four hours a day of sleep for a week, if excellent nights should continue so long, rather than to lose any of the time so valuable; and it is only in this way that very much progress can be made in discovering or measuring difficult double-

stars. One fine night is worth more than a dozen indifferent ones, because stars can be observed, of which a single good measure would be of more interest and value than measures of much greater number of the other class of stars. Hence, if one is going to follow the subject in earnest, he will under no circumstances fail to improve every opportunity to observe a difficult pair. It is always dangerous to put it off for some more convenient time, which may not occur for a year. In the winter, in cold climates, heavy clothing will be necessary, especially for the feet, and there is not much fear of overdoing it, with the temperature much below zero. When the thermometer gets down to ten or fifteen degrees below zero, the observer may find his enthusiasm somewhat cooled off, unless the seeing is very fine.

METHODS OF OBSERVING.

In measuring the double-stars my practice has been to make four or five settings for the position angle, and three on each side for the double distance. This is in accordance with the practice of some of the best observers. Certainly nothing is gained by making a great number of readings on one night, and there is no reason for expecting any better result from a dozen or twenty measures than from the smaller number. It is easier to make the individual readings agree with each other, than to make the mean results of different nights correspond, even when the observations are made apparently under the same conditions. The only way to secure accurate results is to increase the number of nights. Some observers have adopted elaborate plans of assigning weights to each night's work, or getting in some roundabout way the most probable mean result from several observations. It seems to me that nothing is gained if the measures are properly made, by any such course. By no manipulation can good results be obtained from poor observations, and burying them under a load of least squares, probable errors, and assigned weights will not improve them. It has been said of one authority that he seemed to believe "that valuable results could be obtained from any data, however imperfect, by using formulæ with an adequate supply of signs of integration." The best observers simply

take the arithmetical mean of the different measures, and this is undoubtedly all that is necessary to be done. If a reasonably good measure cannot be made, it is better not to attempt it; and one can tell about this as well before commencing, as three or four minutes later when the measure has been made.

A preference has sometimes been expressed for measuring certain classes of double-stars by daylight, or in the early twilight. Ordinarily, I have not been able to see satisfactorily any difficult stars I wanted to measure until very nearly dark, and have seldom found the images sufficiently steady until about an hour after sunset, to make it worth while attempting to make measures. Of course many of the brighter pairs can be seen at any time of the day. I have measured ϵ (Epsilon) Bootis with a 6-in. aperture in broad daylight, and some hours before sunset.

WORKS OF REFERENCE.

For the purpose of identifying double-stars, the observer will need the following catalogues:—

I. Struve's great catalogue, "*Mensuræ Micrometricæ*." The reprint of this work, prepared and published by Lord Lindsay, contains the mean results of all the observations, and is much more convenient to use than the original, as the stars are all arranged in one catalogue in order of right ascension, instead of in classes. The republication of this great, and now scarce, catalogue in a compact form has been of great service to all interested in the subject.

II. Otto Struve's Pulkowa Catalogue. This is a small work, but fully as important as the other, from the larger proportion of close and difficult pairs. Although it contains less than 500 stars, it will be referred to in identifying objects found from time to time about as often as the other, containing more than six times as many pairs. The revised and corrected edition of 1850 should be used. The stars are given without measures, but with places, magnitudes, and approximate distances. Dembowski's measures of these stars will be found in the *Astronomische Nachrichten*, Nos. 1806-1832. The observations of Otto Struve, made since 1840, are contained in Vol. IX. of the Pulkowa Observations.

III. The various catalogues of new stars I have contributed from time to time, a list of which will be found in the Introduction to the "Double-star Observations made in 1877-8 at the Dearborn Observatory," *Memoirs R.A.S.*, Vol. XLIV. These ten catalogues comprise 733 new double-stars, and later discoveries, not yet published, will extend the number to more than one thousand stars; and as a large proportion of them are difficult objects, they are certain to be picked up by anyone successful in discovering new stars. There are but few stars, relatively, in "Mensuræ Micrometricæ" which it will be necessary to stop to identify when found, if one is looking for new stars. Most of those which are not close are too easy with a telescope of much power to be new, and may be safely passed by. For more than 15° south of the Equator, the catalogues of Stone and Howe, of Cincinnati, will be important, as they contain a considerable number of new stars, as well as measures of pairs but little observed heretofore. There are some other late minor lists of new stars; but as they contain altogether only a few objects, they need not be specified here. The several catalogues of Sir John Herschel, although they comprise more stars than all the works above enumerated, will be very little wanted. They were picked up in sweeping, and, with very few exceptions, are faint, wide, and unimportant, and such as would receive no attention from the observers of the present day. All double-stars in the catalogues of Sir William Herschel, close enough to bring them within the limit of distances adopted by Struve, will be found in "Mensuræ Micrometricæ."

For the purpose of micrometrical work, the "Handbook of Double-Stars," by Gledhill and others, and Flammarion's "Etoiles Double et Multiples en Mouvement relatif certain," will be almost indispensable. The former contains much valuable information not to be found anywhere else. The chapters on the telescopes, methods of observing, &c., will be of the greatest service to amateur observers. The catalogue and measures include a large number of the most interesting objects, suitable for all classes of telescopes. Flammarion's work deals only with stars having relative motion,

and gives substantially all the measures, arranged in chronological order, of every pair where there has been any change in the angle or distance of the stars, with notes concerning the character of the motion, periods of binary stars, &c. One can see at a glance just what moving pair most need measuring. Webb's "Celestial Objects for Common Telescopes" is too well known to require any commendation. It has done more perhaps than any other work ever published to interest amateurs in astronomical work, and is not likely to be superseded by any similar work. Though founded upon Smyth's "Bedford Catalogue," and to some extent indebted to that work, Mr. Webb, in the extracts made, has managed to avoid most of the mistakes which illustrate almost every page of Smyth relating to double-stars. The new edition, issued in the latter part of 1881, contains a large amount of new matter, and should be in the hands of every amateur observer.

Mr. Chambers has recently published a revised and enlarged edition of the "Bedford Catalogue," omitting many of the erroneous measures of Smyth, and giving very late measures of the more interesting double-star systems, of which several hundred are given, not contained in the original edition.

The numerous series of measures by the various double-star observers are very convenient for reference; but the works I have mentioned will answer all practical requirements of the amateur observer, for some time at least. A general catalogue of double-stars is very much needed by all classes of observers, and those interested in the subject, for the identification of stars, and for selecting suitable pairs to observe. The so-called Herschel's "General Catalogue of Double-Stars," is of no use for any conceivable purpose. It contains about all the mistakes which have ever been made by anyone concerning the stars in question, and in addition, many others. It omits entirely several hundred of the most interesting double-stars, including a portion of the Pulkowa Catalogue, and, as an offset or compensation, includes a large number of stars, perhaps as many more, which are not only not double at all, but have never been suspected or

regarded by anyone at any time as double. These defects, however, are of little consequence, and not worth correcting, because if the work was entirely free from them, and without errors of any kind, it would still be, from the entire absence of all description of the stars, and information of any kind concerning them, practically useless. It is unfortunate that this catalogue could not have been prepared by Sir John Herschel.

A good star map is very desirable, and for general observatory purposes I have found Proctor's Atlas better than Argelander's, Heis', or any other with which I am acquainted. Some of the points of superiority are: the method of representing magnitudes: attaching the letter or number to the Flamsteed stars, omitting the constellation figures, thereby rendering the map much clearer and easier to use in comparing it with the heavens, &c. To keep up with the current discoveries and observations, the astronomical periodicals, and particularly *Monthly Notices* of the Royal Astronomical Society, *Astronomische Nachrichten*, *Astronomical Register*, and *Observatory* should be consulted.

STAR CATALOGUES.

For fixing the places of new double-stars, certain star catalogues will be necessary. For a single catalogue Lelande's is perhaps the most serviceable, as it includes nearly 50,000 stars, distributed over the whole area of the northern heavens. For particular regions the following may be named as being likely to contain most of the small stars wanted: within 10° of the North Pole, Carrington's Catalogue; from the Pole to 45° north declination, Oeltzen's Argelander, and Radcliffe; from 45° to 15° north declination, Weisse first catalogue; from 15° north to 15° south, Weisse second catalogue, Schjellerup, Berlin, and some of the Lamont Zones; from 15° to 31° south, Oeltzen's Argelander, Lamont's Zones, and Washington Zones. Dr. Gould's recently published *Argentina Uranometriæ* contains all stars down to the seventh magnitude from the South Pole to 10° north of the Equator, and is invaluable to southern observers. Equally indispensable to astronomers in the southern hemisphere is Stone's "Cape Catalogue of 12,441

Stars for 1880." Occasionally stars will be picked up which cannot be found in any of the catalogues mentioned. Reference must then be made to the Zones of Argelander, the three volumes of which contain all the stars down to the ninth magnitude between the Equator and the North Pole, comprising in all more than 324,000 stars. Every observer should have this catalogue to fall back on, and for its accurate determination of magnitudes. The star places are only close approximations, but near enough for all practical purposes. In identifying small stars, and particularly in crowded parts of the heavens, it is best to take the readings of the circles on one or two of the brightest neighboring stars, as well as the new double-star. It will take but a minute or two longer, and will frequently prevent uncertainty when the star catalogues are referred to for the place of the required star.

The foregoing suggestions are such as have occurred to me in hurriedly going over the subject for this purpose. They are necessarily incomplete, and many points, perhaps equally important, are left untouched. To consider thoroughly in all its bearings a subject of so much magnitude, and of so wide a range, would far exceed the limits of the present article. In conclusion, I would caution the amateur observer against attempting to cover too much ground, or taking hold of too many kinds of work. It is only by persistently sticking to one thing, that substantial results can be accomplished. If double-star work is to be taken up, let the sun, moon, and other heavenly bodies take care of themselves; or, at any rate, trust them to the observers who are making these objects a special study. It is better for science, and better for the observer, that he should strictly confine himself to whatever branch of observation he may select. Any one of the numerous subdivisions of astronomical work is enough for the whole time and best efforts of any observer. The universe is too vast, and life too short, to undertake more.

The national standard time bill (No. 5009) will probably not be reached during this term of Congress.

AURORA BOREALIS IN MINNESOTA.

SOME OBSERVATIONS MADE THEREON IN 1860 AND 1861,

BY CHAS. S. BRYANT.

On the 13th of March, 1860, at the town of Wabasha, on the Mississippi river, between the foot of Lake Pepin and the mouth of the Zumbro river, and nearly opposite to the mouth of the Chippewa river, at 10 o'clock, p. m., of that day, an electrical exhibition took place of a peculiar and noteworthy character. Of this phenomenon, I extract some items from an old record taken at the time. The frost was yet on the ground, and Lake Pepin was covered with ice twenty inches thick. The day previous had been warm, but after sundown the air suddenly cooled down to a low temperature. The river below the lake had been open some time, and a steamboat, on the night above named, came up the Mississippi from some point below. Apparently in the track of the boat, when nearing Wabasha, a column of fleecy, vaporous character, but slightly luminous as it arose above the river banks, ascended from the surface of the water, and in a short time reached far upwards towards the heavens, and soon extended over the valley to the bluffs of the river on either side.

In the case above, as the electric storm went upwards, the light increased to brilliancy so intense that the beholders imagined the prairies on the bluffs were on fire, and yet the only light exhibited came from the peculiar phenomenon arising from the river, and the air immediately around them and over their heads.

Another exhibition of a similar, but somewhat varied character, took place on the night of April 11, 1860, at 8 o'clock, p. m., at the place named above. The peculiarity of this case consisted in the varied movements of vaporous points not wholly unlike the discharge of condensing steam, suddenly expelled from the escape pipe of a steamboat, or the curling white smoke from a tobacco pipe, greatly increased in size, as it floated in curls upwards into the air, expanding and losing its characteristic form in a denser mass higher up in the heavens.

This exhibition could scarcely been more striking had ten

thousand steam engines, of many horse power, been stationed in mid heavens, puffing under a full pressure of steam, creating an aerial current of slightly colored vapor, leaping with cataract speed towards the starry heavens, and there disappearing in the invisible ocean above !

In this case there was no visible crown, or arch, from which lights usually shoot up and walk along the edge of the rosy fringed bow, from the east to the west, until by regular and gradual descent, they sink below the horizon, and cease to tinge the heavens above; but to the more southern observer, no doubt, the usual arch might have been seen, and the usual colored lights like specters continued their parade along the northern heavens, until lost in the brighter light of the coming sun, on the morning of the next day.

The exhibitions in March and April, 1860, in each case took place while the frost was yet in the ground. The day previous to the one in April had been warm, the temperature 60 degrees Fahrenheit, and cooled suddenly after sun down. The one in March, 1860, took place when snow, in places, still lay upon the ground. Perhaps the earth being frozen or covered with snow became insulated, and the electric current could escape only through the atmosphere, into the heavens.

On the 8th of March, 1861, took place in the valley of the Minnesota, at St. Peter, another phenomenon of the character above, with peculiar variations. After sunset, there gathered in the east a dense deep blue electric zone, several degrees in width, and so storm-like as to induce the remark that "an awful thunder storm was lying off, low down in the eastern horizon;" and yet there was no storm in that direction at the time. By 12 o'clock at night a well defined auroral arch, with center due east, tapered off to the north and south till lost below the line of vision. The upper edges of this blue belt had a light, fleecy border, through which the stars shone distinctly. This border sustained a flame of low type all along the crown of the arch. At about three o'clock on the morning of the 9th, a high, furious wind from the northwest blew towards the point in the east where the zone of the aurora belt appeared the night before.

Towards the evening of the 9th a snow storm came on and the temperature fell to within ten degrees of zero, and the falling vapor became frozen specula of ice. Soon after 8 o'clock, the most peculiar aurora appeared in the northern heavens, extending upwards, it soon reached the zenith, and passed still southward, until Orion and the Pleiades were slightly obscured by the gauzy streamers. In the north, during this display, lay a luminous bank of flame-tinged vapor, giving off a light about equal to the light of a full moon. The hair-like striæ forming streamers floated as if attached at one end to a flag-staff, filled the canopy over head, waving from side to side, and flashing with light at short intervals until each streamer in turn faded out into the light of the stars.

The record from which these samples have been abstracted goes to show that the aurora borealis is not exclusively a northern exhibition, but more likely to occur in places where the air is subject to the most sudden changes, which in Minnesota takes place soon after sundown in the spring and fall of the year. After sundown in this latitude the upper portions of our atmosphere suddenly cool. This sudden change produces electrical action by the condensation of the vapor. The oxygen contained in the vapor, having greater affinity for heat set free, than for the hydrogen, causes a mild form of aerial combustion, by the burning of the oxygen and hydrogen of the vapor in the regions of rapid condensation. When combustion takes place, the vapor is reformed, and thus the electric fire burns on until a common temperature supervenes, and the flame of the aurora ceases, sometimes early and sometimes late at night, but generally before midnight. It is apparent that the aurora must have its origin in some action of the sun.

AN important bibliographical work has been undertaken by Mr. Chandler, viz: the collecting of references to observations of stars of known or suspected variability. On the completion of this work it is intended to measure comparisons-star photometrically.

**SOME HINTS AND DIRECTIONS TO OBSERVERS
FOR RECORDING METEORIC PHENOMENA.**

E. F. SAWYER.

During the past few years many experienced and eminent astronomers have given great attention to the collecting and discussing of meteoric observations, and a great variety of important astronomical facts have been deduced from the data thus collected. Much of the material contributed has, however, been gathered by amateur observers of meteors, and to this class, this field offers special attractions for original observation and research: owing to the fact that no well appointed or expensive observatory or instrumental equipment is necessary in order to successfully prosecute the work. It is not the writer's intention, however, to enter into a discussion regarding the probable origin of meteors or the many theories that have been advanced by eminent astronomers respecting the same, but to direct attention to a branch of astronomy at present sadly neglected in this country, and give some hints as to the best methods of observing and describing accurately the many notable appearances which these celestial bodies present, and the manner of recording the same, so that the record may be of value. The writer's own experience as an amateur will be given: but the valuable directions to observers published by the British Association Luminous Meteor Committee can hardly be improved upon, and have been freely used in the preparation of this article. The meteors to be recorded are divided according to magnitude, or other peculiarities, into various classes as: First, Telescopic meteors, which owing to their faintness can only be seen by aid of the telescope; second, shooting-stars, visible to the unassisted eye, and comparable to the different apparent magnitudes of the fixed-stars in brightness; third, Bolides and Fireballs, or very bright meteors, equal or exceeding the planets Jupiter and Venus in brilliancy, and often comparable to the different phases of the moon, and quite rarely rivaling the sun by daylight apparitions: fourth, Deton-

ating, or Aerolitic meteors, which produce an audible explosion, being comparable to a distant cannon, a peal of thunder, or an earthquake shock, by their concussion with the air; and fifth, Stonefalls and Ironfalls, which sometimes occur singly and occasionally in a shower.

The methods of recording these different apparitions differ somewhat, so that it is necessary to give separate and somewhat independent directions and instructions to enable observers to record useful accounts of the phenomena. First, Telescopic meteors are generally noticed while observing other astronomical phenomena. During the prevalence of meteor showers however, they have occasionally been looked for especially and many interesting and valuable observations of such meteors have been placed on record.

"The point to which a telescope is directed (in R. A. and Decl.)," with the time to the nearest minute when such an object is observed, "and its brightness compared with that of fixed-stars seen with the same telescope, is to be stated; and the position-angle of a diameter, or a radius of the field of view drawn parallel to the direction *towards which* the meteor shot, should be determined in the degrees or quadrants usually adopted by astronomers, making the allowance for inversion of the image which the telescope requires with as much precision as can be ensured. The length of path, if not prolonged beyond the view of the telescope, can be stated by comparison with the known width of its field in minutes or parts of a degree of arc; and deviations of brightness, change of brightness and appearance of the head, during its passage, as well as the persistence on its track of a streak or of sparks, if visibly remaining, should be noted with the duration in seconds, as nearly as it can be estimated, of the meteor's flight, while the nucleus was in sight. A streak will often mark the line of passage of a meteor which crosses the field of view too swiftly to be followed with the eye, and the breadth of this light-streak in minutes or seconds of arc should then be noted, with its brightness and duration, appearance and changes of appearance, and with the magnifying power of the telescope employed. A star spectroscope should also be used, if possible, to ob-

serve its spectrum, if it is of sufficient brightness and duration."

"As it has been contended that telescopic meteors are rendered visible by optical power at vastly greater distances from observers than ordinary shooting-stars can be seen, and that their apparent speeds and lengths of path are, under these circumstances, greatly reduced by distance and rendered inferior to those of the majority of meteors, observations of small telescopic meteors with short slow courses, if they occur, should be carefully recorded, in order to determine if they are principally seen at low apparent altitudes, and moderate, real heights only, or with equal frequency at all angular altitudes above the horizon, and therefore at all possible heights above the earth's surface to which the use of astronomical telescopes of the highest powers and apertures enable us to extend our sight."

"Second, Shooting-stars are observable with a certain frequency on all cloudless nights. The result of an attentive watch on such occasions to note their frequency by a few hours' observation, especially if in the absence of the moon is of great value: but the fitful activities of many meteor showers often combine together to render a rate of frequency concluded from a single hours' observations deceptive and misleading: and attention must be paid to noting the middle time of the watch to the nearest quarter of an hour, as upon its lateness in the night, as well as on the season of the year, depends the average herary number which a single observer may expect to see. In comparison with that of an evening hour at six o'clock, the number visible in the same morning hour is about double, and nearly as notably greater for a midnight hour in August or September, than for one in February or March. For an average midnight hour in the whole year, Quetelet estimated the herary number visible to one observer in a European station as about six meteors: and a greater number than twelve or fifteen meteors seen in an hour at an average time of night and season of the year, may be regarded (though not certainly) as indicating an active exhibition of some special meteor shower. It is of the prominence which such excep-

tional phenomena sometimes reach as meteoric spectacles, that the distinction which has arisen between shower meteors and sporadic shooting-stars is entirely owing; and from the partial extent of our present acquaintance with the directions, intensities and duration of multitudes of weaker descriptions of such showers, innumerable shooting stars must still be regarded as 'sporadic,' until well determined centers from which they appear to diverge accurately can be definitely assigned to them."

(TO BE CONTINUED.)

CORRESPONDENCE.

NOTE ON δ^2 ERIDANI.

The position of this interesting group of stars for 1880.0 is

$$\alpha = 4^h 9^m 49^s; \delta = -7^\circ 49'$$

The brightest star is of the fourth magnitude, and at a distance of $82''$ in angle of position 106° . There is a pair of stars of the tenth and eleventh magnitudes, which probably belong to the same system, since these three stars have a common proper motion of $4''$ a year. Between the bright star and its two faint companions there is a small star of the twelfth magnitude which does not share in the proper motion of the group. This group has some resemblance therefore to 61 *Cygni*, and on account of its great proper motion and the distance of the two faint companions, it is probable that we have here a case of large stellar parallax. This star is not however well situated for an observer in north latitude, since it is in south declination, and not easily followed throughout the year. It is possible, however, that some useful observations may be made by an observer in our latitude. The coefficients of parallax are:

In right ascension 0.983.

In declination 0.509.

It would be better, therefore to observe distances in right ascension if one had a micrometer that could be used for this purpose.

A. HALL.

HINTS ON DOUBLE-STAR OBSERVING.

Mr. Burnham's "Hints on Double-Star Observing" are valuable and interesting, although I might probably take exception to one or two of his conclusions. For instance, instead of being absurd, I think it is important to adopt, as far as possible, an "invariable rule" both in the measurement of angles and of distances. The detection and elimination of personal errors is practically impossible without some such rule.

The formulæ for the rejection of double-stars quoted on page 14* was first given in my report to the *Astronomische Gesellschaft* on the work done at this observatory during the year 1877. It was not intended as a general rule to be employed in the selection of double-stars "really worth preserving," but merely as a limit in preparing a working list to be used in carrying out a given work. In fact, I have for some time had in view another series of observations, in addition to the one now practically completed, to include all pairs within the power of our equatorial, having a distance less than $2''$, and situated between the equator and 30° south declination. I am perfectly willing to agree that a $1''$ pair should be saved in all cases, but even his formula does not do that. On the other hand, I cannot agree that there is no "sufficient reason for varying the limiting distance on account of the magnitude of the companion." If, for instance, we consider pairs whose components are of the same magnitude, I think an inspection of Mr. Burnham's table will show at a glance that his distances are too small. He certainly would not be in favor of rejecting as unworthy of further notice all eighth magnitude pairs whose distances are greater than $5''$. I do not believe a single formula to be used indiscriminately by all observers is advisable. As science advances, and as our instrumental means and methods of observation are improved, the choice of objects to be observed will change. No series of observations, however, should be undertaken without a definite object in view.

ORMOND STONE.

* Vol. 1, No. 2.

WELLS' COMET.

On May 1, Wells' comet was seen to occult a star of the tenth magnitude. The comet passed almost centrally over the star, and for a number of seconds, the two could not be separated, with a power of 400, on the 18½-inch refractor. The conjunction occurred May 1, 8^h 22.3^m M. T.

The approximate diameter of the envelope surrounding the nucleus was about 12" of arc. On May 15, the brightness of the nucleus was estimated equal to that of a seventh magnitude star, and on May 23, equal to 6½ mag. star. It may be inferred from these estimates of brightness, that the comet will be visible to the naked eye about June 1, but it will be very unfavorably situated for seeing.

G. W. HOUGH.

Dearborn Observatory, May 24, 1882.

EDITORIAL NOTES.

WILLIAM R. BROOKS, Red House Observatory, Phelps, N. Y., May 17, writes: "Comet seeking with the 5-inch reflector is regularly carried on every suitable night. Frequent observations have been made of the new Wells' comet from the first morning succeeding discovery. Its increase of brilliancy, development of the nucleus, coma, and tail, have been specially noted and recorded. Solar phenomena receive attention, and the marvelous sun-spots which appeared at the epoch of the brilliant auroral display of April 16, and which by rotation have again appeared, were recorded and drawings made. On the evening of April 18, a very beautiful meteor was seen, about twice the brilliancy of *Venus*, at its brightest. It started about seven degrees above *Vega*, and moved in a northeasterly direction, slowly fading from sight before reaching *Cassiopeia*. It had a faint train, and the estimated period of the meteor's apparition was three seconds.

Comet Wells has been a theme of lively interest among observers for the month past. Telescopes in all parts of the world have been turned upon it, and every astronomer's report, naturally enough, has something to say about it. Some disappointment is felt, that it does not grow bright more rapidly, in view of the predictions of some prominent observers and computers, yet no one could foretell very certainly about that future of the comet because so much depends on the nature and state of the nucleus. We give below a drawing of the comet as it appeared in the Clark 8½-inch equatorial of Carleton College observatory on the evening of May 16, at 9h 30m meantime with power 50. This drawing was made by Professor Armsby and well represents

the comet in its apparent position, as seen in the telescope. This bright star on the right of the nucleus is 50 of *Cassiopeia*, the remaining seven stars were not known. At the time of observation the tail could be traced nearly one degree in length.

COMET α (WELLS) 1882.

Below are given the elements of the orbit as computed by MR. EGBERT of Dudley Observatory, and also those computed by E. LAMP of the Observatory at Keil, Prussia, as given in the *Nachrichten*.

EGBERT.			LAMP.		
T=1882	June 10.	3076, M. T.	T=1882	June 10.	5638, M. T.
	Greenwich.			Berlin.	
$\pi - \Omega = 209^\circ 21' 13''$	} Ecliptic & Equinox 1882.0		$\pi = 53^\circ 54' 39.7$	} Mean Equinox 1882.0	
$\Omega = 204 43 11$			$\Omega = 204 54 49.5$		
$i = 73 38 45$			$i = 73 47 29.2$		
$\log q = 8.769098$			$\log q = 8.783674$		

The following rough ephemeris by Mr. EGBERT shows that the opportunity for observation when the comet reappears from behind the sun will not be favorable for in high northern latitudes.

EPHEMERIS.

Greenwich 12h.		α		δ
June	10	5 ^h	10 ^m .9	+20° 38'
	14	6	23.1	16 30
	18	7	42.6	15 9
	26	8	54.8	13 51
July	12	10	45.1	9 34
Aug.	13	12	21.	3 52
Sept.	14	13	13.	+ 0 16

Observer HESS of Fort Dodge, Iowa, May 21, at 9^h, saw the comet near the middle of a small triangle formed by one 5th and two 6th magnitude stars, the form of which was supposed to be B. A. C. 1001. The nucleus was about the brightness of the sixth magnitude stars.

Professor ORMUND STONE of the Cincinnati Observatory has very recently been appointed Director of the Leander McCormick Observatory of the University of Virginia. The Institution is already in possession of the great refracting telescope made by the Clarks, a few years ago, for Mr. McCormick who generously donated it to the University in 1877. It cost nearly \$50,000 and is probably not inferior to any telescope in the United States. The friends of the University have contributed \$75,000 to endow the chair of astronomy. By a late report of the Board of Visitors a most commendable outlay in the interest of scientific research is shown.

The Warner scientific prizes will find place in our next issue.

Rear Admiral JOHN RODGERS, Supt. of the U. S. Naval Observatory, died on Friday evening, May 5, at eight o'clock. His death is greatly regretted at the observatory, and his family have the heart-felt sympathy of all who had the pleasure of being associated with him. Aside from his scientific attainments, second to none, he was a master of his profession indeed, and the world may be said to have lost one of the finest naval officers of the age. His successors on various Boards, and at the observatory, have not been designated. It is safe to say that several men will be required to do the work which he alone carried on.

E. F. Q.

Under date of May 11, Professor Stone of Cincinnati writes: "In observing one of our D. M. zones (-23° dec.) a remarkable vacuity was found in the region between $16^h 17^m$ and $16^h 25^m$ right ascension. In this region there is no star brighter than 9.5 mag., and only one of that magnitude.

The Observatory gives additional interesting evidences of coincidence between solar activity and our recent auroras. It says: "Between the 16th and 17th of April the spots increased in size in the most remarkable manner. * * * About the same time, a most violent magnetic storm was raging. From about midnight on the 16th to the following evening, there was a continued and violent disturbance of all the elements, declination, longitude force, and vertical force, the greatest disturbance noticed since 1872," again coinciding with our second feeble aurora. Speaking of another group, it says: "Composed principally of two large spots on the 18th, on the 20th it showed three of very considerable size; and again, simultaneous with the spot changes there was another magnetic storm, less violent indeed than that of the 16th, but showing very sharp disturbance."

I. S.

The reputation which Mr. JOHN BYRNE of New York has gained, as maker of object-glasses of excellent finish and definition, is certainly an enviable one. Prominent astronomers are using his telescopes in Europe as well as in America. A list of his recent telescopes will appear soon.

Especial attention is called to the fact that we are prepared to offer HARRISON's excellent telescopic picture of the moon for two subscribers to the MESSENGER, or \$4 before the first day of July next. The advertisement elsewhere will give full particulars.

It was reported by telegraph that the total eclipse of the sun was successfully observed in Upper Egypt, May 17, by English, French and Italian astronomers, and that a fine comet was discovered, and other important observations made. The report thus far lacks confirmation.

American astronomers have been looking for something official or otherwise respecting the performance of the great Vienna refractor of 27 inches aperture, made by GRUBB of Dublin. This instrument, the largest of its kind in the world, has been mounted a year or more, and is in charge of one of the most eminent of European astronomers. If the object-glass is a good one, as we trust it is, it is due the maker that the fact should be known, to say nothing of the expectations of the astronomical world.

The display of Lyrid meteors which usually occurs on April 18-20 was very meager this year. By concerted action, watchers in Poughkeepsie, N. Y., and Haverford, Pa., were to make observations as to their height in the atmosphere. On the morning of the 18th not more than four an hour were observed at either station, and on the 19th still fewer. Perhaps the maximum occurs earlier than usually given.

I. S.

Our genial astronomical friend, C. H. R., of the Empire State, says that twenty-five copies of the May MESSENGER requested, were thankfully received, and that "the said copies are already on their several routes to PERU, WASHINGTON TERRITORY, HUDSON'S BAY and SANDWICH ISLANDS."

Dr. DRAPER's photograph of the *Great Nebula of Orion*, and the photograph of the spectrum, not yet given to the public, are spoken of, by private viewers, as specimens of high art. They will be issued probably with the next volume of the Washington Observations.

The flint disc for the 36-inch objective to be made by ALVAN CLARK & Sons for the Lick Observatory, is on its way to this country. Its diameter is 97 c. m., (38.19 inches), its thickness 55 c. m., (21.65 inches) and its weight 170 kilogrammes (375 pounds). A month was required in the cooling. A crown disc has also been cast by M. FEIL (fils) who made the flint.—*Nature*, 1882, Feb. 6.

THE LALANDE MEDAL.

The following list of those who have received this medal, is extracted from the V. G. S. Ast. Gesell. 1882.

Y'R.	RECIPIENT.	FOR WHAT AWARDED.
1803	Oibers,	Discovery of <i>Pallas</i> .
1804	Piazzi	Catalogue of stars.
1806	Harding and Svanberg, ..	For <i>Gunn</i> ; and for geodetic operations.
1807	Olbers,	For <i>Vesta</i> .
1808	Mathieu,	Pendulum observations.
1809	Gauss,	Theoria Motus.
1810	Poisson,	For his published memoirs.
1811	Oltmanns,	Computation of HUMHOLDT's observa-
1811	Bessel,	Memoirs on <i>Saturn's</i> system. [tions.
1812	Lindenau,	Tables of <i>Mars</i> .
1813	Daussy,	Theory of <i>Vesta</i> .
1814	Piazzi	Catalogue of 7,500 stars.
1815	Mathieu,	Theoretical researches.
1816	Bessel,	Memoir on <i>Saturn's</i> satellites.
1817	Pond,	Parallax of stars.
1818	Pons,	Discovery of three comets.
1819	Nicollet,	Libration of the Moon.
1819	Encke,	Memoir on ENCKE's comet.
1820	Nicollet,	Discovery of comet 1821, I.
	Pons,	Discovery of a comet.
1823	Runkel,	For comet observations, etc.
1823	Gambart,	Theory of ENCKE's comet.
1824	Damoiseau,	Observations of double-stars.
1825	Herschel and South,	Pendulum observations.
1826	Sabine,	Discovery, etc of three comets.
1827	Pons,	For their work on geodetic and astro-
	Gambart,	nomical observations in 1821-3.
1828	Carlini,	Observations, etc., of the new comet.
	Plana,	For making astronomical instruments.
1830	Gambart,	" " "
1830	Gambey,	Discovery of a comet.
1830	Perrelet,	Theory of a comet's head.
1832	Gambart,	For his work on double-stars.
1833	Valz,	For his publications in general.
1833	Herschel,	Discovery of two comets.
1834	Airy,	Discovery of a comet.
1835	Dunlop,	New map of the moon.
1835	Boguslawski,	For glass-manufacture.
1836	Beer,	For his work on geodesy.
	Madler,	Discovery of three comets.
1837	Guinand,	Discovery of a comet.
1838	Brousseande,	" " "
1839	Galle,	" " "
1840	Bremiker,	" " "
1842	Laugier,	" " "
1843	Mauvais &	" " "
	Faye,	" " "
1844	De Vico &	" " "
	D'Arrest,	" " "

Y'R.	RECIPIENT.	FOR WHAT AWARDED.
1845	Hencke.....	Discovery of an asteroid.
1846	Galle.....	Discovery of <i>Neptune</i> .
1847	Hencke and Hind.....	Discovery of asteroids.
1848	Graham.....	" "
1849	De Gasparis.....	" "
1850	De Gasparis and Hind.....	" "
1851	De Gasparis and Hind.....	" "
1852	De Gasparis, Hind, Luther, Chacornac and Goldschmidt.....	" "
1853	De Gasparis, Hind, Luther, Chacornac.....	" "
1854	Luther.....	{ " "
	Chacornac.....	
	Goldschmidt.....	
	Hind.....	
	Ferguson.....	
	Marth.....	
1855	Luther.....	{ " "
	Chacornac.....	
	Goldschmidt.....	{ " "
1856	Pogson, Chacornac.....	
	Goldschmidt.....	{ " "
1857	Goldschmidt.....	
1857	Bruhns.....	Discovery of Brorsen's comet.
1858	Goldschmidt.....	{ Discovery of asteroids.
	Laurent.....	
	Searle.....	
1858	Tuttle, Winnecke &.....	{ Discovery of comets.
	Donati.....	
1859	Luther.....	Discovery of asteroids.
1860	Luther, Goldschmidt & Chacornac, Ferguson.....	{ " "
	Foerster, Lesser.....	
1861	Luther, Goldschmidt & Tempel.....	{ " "
1862	Clark.....	Discovery of a companion to <i>Sirius</i> .
1863	Chacornac.....	For his star charts
1864	Carrington.....	For his solar observations.
1865	De la Rue.....	For his celestial photography.
1866	Maclear.....	For his geodetic observations.
1867	Schiaparelli.....	For his theory of meteors, etc.
1868	Gaussen.....	Spectroscopic observations of the solar
1869	Watson.....	Discovery of 9 asteroids. [prominences.
1870	Huggins.....	For his spectroscopic observations, etc.
1871	Borrelly.....	Discovery of an asteroid.
1872	P. Henry.....	{ " 3 "
	Prosper Henry.....	
1873	Coggia.....	Discovery of a comet.
1874	Monchez.....	{ For their observations of the transit of Venus.
	Bouquet de la Grye.....	
	Fleuraud.....	
	Andre.....	
	Heraud.....	
	Tisserand.....	

Y'R.	RECIPIENT.	FOR WHAT AWARDED.
1875	Perrotin	For his asteroid discoveries, etc.
1876	Palisa	" " "
1877	A. Hall	For his discovery of <i>Mars'</i> satellites.
1878	Meunier	For his work on meteorites.
1879	C. H. F. Peters	For his discoveries of asteroids.
1880	E. G. Stone	For his catalogue of 10,000 stars. {lax.
1881	D. Gill	For his determination of the solar paral-

DEFINITIVE POSITIONS OF THE RED STARS.

Part IV. of the *Astronomical Observations and Researches made at Dunsink, the Observatory of Trinity College, Dublin*, contains the mean places of 321 red-stars, deduced from observations made with the meridian circle at Dunsink by Dr. J. L. E. DREYER.

The work contains about 1140 observations of the 321 stars each of which has been observed on the average $3\frac{1}{2}$ times. Of these observations, 445 were made by Dr. COPELAND in 1875-76, and the remainder by Dr. DREYER in 1878-80.

The epoch of the catalogue is 1875.0, and the system is that of the Astron. Gesell. zones, so that subsequent comparisons will be easy. The work begins with an account of the PISTOR & MARTINS meridian circle. Its aperture is 6.38 inches, focus 8 feet. The power used has been 180. This circle is similar in design to those of Ann Arbor, Albany, Copenhagen, Leyden, Washington and Leipzig. The standard clock by DENT is mounted in the observing room. The observations have been made by eye and ear over wires only 3.2 apart, and Dr. DREYER says, what is tolerably clear, that this interval is too small. The pointing in declination is done by means of two threads $14''$ apart.

There is a difference in the size of the (exactly cylindric) pivots equal to $-0''.10$. The *collimation* has been determined over mercury. The *equator-point* has been determined from the zero stars of the Astron. Gesell. The latitude is not definitively determined, but is taken at $53^{\circ} 23' 13''.0$

There is a difference in the horizontal flexures of the instrument, Cl. E. and Cl. W., but the absolute flexure is small. Both circles are finely divided, and the division errors of each are given. The eight micrometer screws have been twice investigated. The constants of the instrument have been investigated by all the various methods, and the results by the various ways agree well.

Dr. DREYER would confer a favor if he would describe in detail his plan for getting the exact position for the counterpoise weights referred to on page seven. It would be interesting to know how much weight is allowed to remain on the Ys in the various meridian circles of the world. The *reductions* are purely differential, as has been said. The refraction is computed by BESSEL's tables, with the Greenwich modification.

The probable error of a clock correction derived from one star is
 ± 0.052 ,

and of a single determination of the equator-point, ± 0.55 , or from 4 stars, ± 0.28 . The resulting *p. e.* of a single declination is, above -10° , ± 0.63 , and from -10° to -26 , ± 0.73 .

For comparison with this work we can refer to the Ann Arbor declinations of 195 stars, made with a circle of exactly the same size as that of Dublin, and also by the same makers, and published by the Washburn Observatory.

This catalogue was observed by Mr. SCHJEBMÆ in 1879, and the *p. e.* of a single night in declination is ± 0.55 ; in R. A., ± 0.040 sec. d SCHJELLERUP at Copenhagen, (10,000 stars *p. xvi*), found between 0° and $+15^\circ$ *p. e.* in Dec. ± 0.69 , and between 0° and -15° , ± 0.95 .

The magnitudes of the stars have been assigned on ARGELANDER's scale, and a note of the color of each star is given for each observation.

The main object of the work is to leave good determinations of position of a large number of red stars, which may serve to show if the red stars as a class have any peculiarities of proper motion.

Besides this object, another has been attained, in that 321 red stars have been observed for color and magnitude on three or four nights each on the average.

Dr. DREYER has now undertaken the observation of a large number of zero stars for SCHOENFELD's *Durchmusterung* with this circle, which like the large refractor of the observatory, is not destined to be idle.

E. S. H.

NEW ASTRONOMICAL JOURNAL.

M. FLAMMARION has recently founded a new popular astronomical journal, having for title: *L'Astronomie, revue mensuelle d'Astronomie populaire, de Meteorologie et de Physique du Globe*.

No. I. is dated March, 1882, and contains a good account of the Observatory of Paris, with wood cuts of its appearance in 1672, and at present. A list of the instruments in use is given, which we copy:

	Aperture.
GAMBAY Transl.....	5.91 inches.
GAMBAY Mural Circle.....	4.74 "
(1) EICHENS Meridian Circle.....	9.48 "
(2) " " " ".....	7.48 "
LEREBOURS Equatorial.....	14.96 "
SECRETAN ".....	12.20 "
SECRETAN ".....	9.44 "

A short and interesting history of the administrations of the various directors is given, most attention being naturally paid to the present one. The salaries paid are:

Director.....	15,000 francs.
Vice-Director.....	12,000 "
Astronomers.....	7,000 to 10,000 "
Adjunct astronomers.....	3,500 to 7,000 "

The meridian observations are to-day chiefly devoted to a reobservation of the LALANDE stars, some 48,000 in all. Probably the places of

some 23,000 LALANDE stars will be printed in 1882. The ten observers obtain some 28,000 observations yearly.

The six observers with the equatorials are engaged on the observation (and discovery) of asteroids, double-stars, etc. The reflector of 47 inches aperture is not in use. The large refractor of 29.13 inches aperture will be mounted shortly.

E. S. H.

SPECTRUM OF THE NEBULA OF ORION.

Dr. HUGGINS has obtained a fine photograph of the spectrum of this nebula, which shows a *new* line λ 3730 in addition to the four which he has located in the visible spectrum.

In this connection it may be worth while to correct a common, although a natural, error with regard to the question of the discovery of the discontinuous nature of the spectra of nebulae.

In August, 1864, Dr. HUGGINS investigated the spectra of nebulae before any other observer, and communicated the results to the Royal Society on September 8, 1864.

SECCHI's observations of the spectra of nebulae are published in the *Comptes Rendus* of 1865, and appear to be the record of an independent discovery; certainly they are usually so considered. That they are not independent may be seen from the fact that the results of Dr. HUGGINS were communicated to P. SECCHI by Director OTTO V. STRUVE, who was at the time on a mission to Rome. SECCHI received the announcement with incredulity, but as STRUVE insisted on its correctness, SECCHI pointed on a nebula and saw the gaseous spectrum for the first time in consequence of this announcement. This may not seem important now, but it is a portion of the history of astronomy, and if recorded at all, should be stated correctly.

E. S. H.

TRANSIT OF VENUS.

The following stations have been selected by the French government: Guadeloupe or Martinique, M. TISSERAND in charge; Cuba, M. D'ABADIE; Florida, Col. PERRIER; Mexico, M. BOQUET de la GRYE; Patagonia, (Rio Negro), M. PERROTIN; Santa Cruz, Capt. FLEURBAIS.

The following names have been assigned to newly discovered asteroids: 205, Martha; 207, Hedda; 208, Lacrimosa; 210, Isabella; 211, Isolda; 212, Medea; 214, Aschera; 216, Cleopatra; 218, Bianca; 219, Thusnelda.


E. S. H.

VARIABLE STARS.

An ephemeris of the variable stars, similar to those of previous years, has been issued by the *Astronomische Gesellschaft* for 1882. It contains the times of maxima and minima of most of the variables whose periods are known, including, in addition to Algol, five stars of the Algol-type, viz: λ Tauri, S Cancri, δ Libræ, U Coronæ, and U Cephei. A minimum of Mira Ceti is fixed to February 3—this phase has been much less observed than the maximum. Both this minimum and the following maximum on May 23 are dated about ten days earlier than Argelander's formula of sines would indicate, but the observations of the last ten years have shown additional perturbation.—*Nature*.

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CALENDAR FOR 1882.

Spring Term began Wednesday March 29, and ends June 15, 1882.

Term examinations, June 12-14, 1882.

Examination to enter college department, June 9 and 10 and Sept. 5,

Anniversary exercises June 11-15, 1882.

Fall term begins Wednesday, Sept. 6, 1882.

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NORTHFIELD, MINN.

Telescopic Pictures of the Moon.

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TESTIMONIALS:

Your Painting of the Moon arrived safely, and was inspected by all the gentlemen connected with the Observatory. They at once agreed that, so far as coloring is concerned, it is a remarkably artistic representation of our satellite; but the equally important question of accuracy of outline was not so easily settled. To test it, Admiral Rodgers directed Assistant Astronomer Paul to compare the picture with some of the best lunar maps, and, I am happy to say, the result was all that could be desired. The details are perfectly correct, not only in the illuminated portions, but even in the dark parts, which shine only by earth-light. I therefore congratulate you on having produced a most faithful portrait of the moon as seen through a good telescope. I also enclose a letter from Admiral Rodgers to myself, which you will find of interest, and remain,

WM. HARKNESS.

U. S. NAVAL OBSERVATORY,
Washington, D. C.

We have examined Mr. Harrison's picture of the Moon and think it one of the best that we have ever seen.

ASPAH HALL,
J. R. EASTMAN,
EDWARD S. HOLDEN,
H. M. PAUL,
A. N. SKINNER,
EDGAR FRISBY.

Your painting of the moon appears to me to possess great artistic and scientific interest. It certainly presents the telescopic aspect of the moon more truthfully than any drawing I have yet seen. I think chromo-type copies of your series of paintings would be of great use to science teaching.

R. A. PROCTOR.

I am glad to learn that you propose to publish chromo-lithographic copies of your paintings of the moon, which I have examined with great interest; if the copies are as faithful representations of the color, illumination and general picturesque effect of the moon as is your painting, I am sure they will be a great acquisition to students, teachers and amateurs of Astronomy.

LEWIS M. RUTHERFORD.

I am very glad to learn that you propose to issue chromo-lithographic copies of your oil-painting of the Moon. If the copies approach the painting in general effect, they will certainly be of great value to the instructor.

HENRY DRAPER

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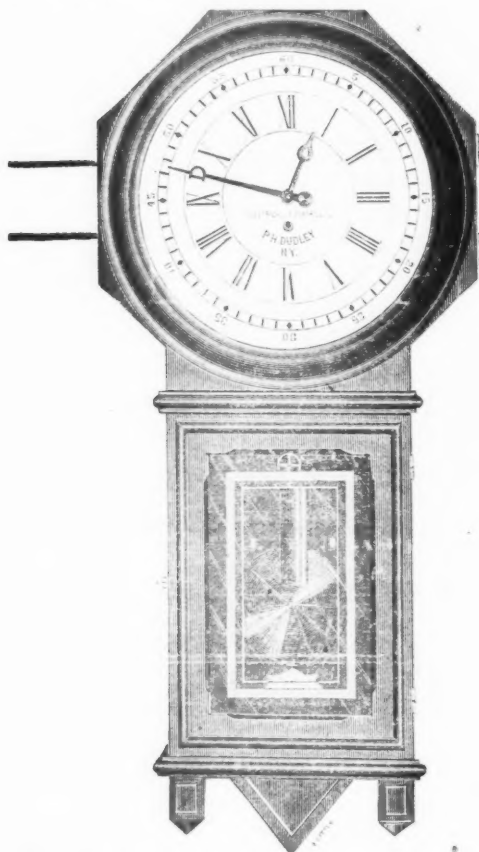
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